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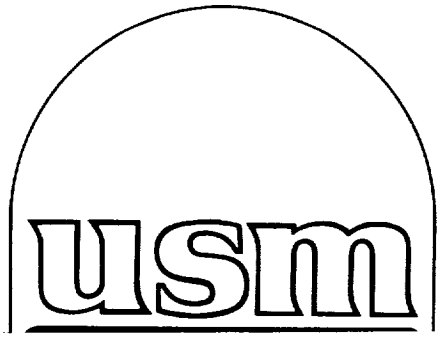




SCIENCE AND TECHNOLOGY

CONTINUATION OF THE DEVELOPMENT OF SOFTWARE TO BE USED IN SUPPORT OF OPERATING REQUIREMENTS OF THE NASA TECHNOLOGY UTILIZATION PROGRAM

# CONTINUATION OF THE DEVELOPMENT OF SOFTWARE TO BE USED IN SUPPORT OF OPERATING REQUIREMENTS OF THE NASA TECHNOLOGY UTILIZATION PROGRAM

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## EXECUTIVE SUMMARY

For the past twenty-two months, the University of Southern Mississippi (USM) has been developing a "Searcher's Workstation."

This has resulted in a set of personal computer hardware and software to support the specific endeavors of bibliographic database searchers, which is a major activity within NASA and its subcontractors, specifically the Industrial Application Centers and the State Technology Assistance Centers.

The project has proceeded by: specifying the needs, surveying commercially and otherwise available products which might be pieces of the solution, and building the pieces (software only) of the solution which could not be found commercially.

Progress to date includes the development of a prototype searcher's workstation on a VAX minicomputer and the installation of a version on the IBM-PC. The IBM-PC implementation offers the most utility for NASA's purposes. For the coming year, USM proposes to optimize the performance of this PC version and to make it available to selected sites for evaluation. Also, our experimental research initiatives in this problem area will be continued.

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# 1. UNDERSTANDING OF THE PROBLEM

## 1.1 Bibliographic Database Searching and Technology Transfer

The NASA technology transfer process is regarded as an information system. A primary output is known as the "industrial applications study."

The actual processes involved in the industrial applications study are shown in flow chart format in Figure 1. The first step in the process is the formulation of the problem statement. Once the problem is formulated, a series of databases are selected. These may be either commercial, e.g., DIALOG, or public domain, e.g., NASA RECON. Using database thesauri, the search strategy is formulated and a series of keywords chosen. An on-line search is conducted and a number of abstracts retrieved. These are then reviewed for relevance and a number of documents ordered. The documents can then be analyzed and, if warranted, government and/or industrial contacts instituted. Information from experts in conjunction with the assessment of the published information is used to formulate the final report.

Another primary output is the "current awareness search." The steps carried out in a current awareness search are similar, but are normally terminated after the on-line search, i.e., the final report consists of the retrieved abstracts.

Presumably, the recipient of the abstracts carries out the abstract review and analysis procedures and contacts the relevant experts.

The labor intensive steps in the above process are associated with the review of the abstracts for relevance, the analysis of the relevant publications and the preparation of the final report. Analysis and report writing labor can be reduced through the employment of computer information systems tools and techniques. This is discussed in the following sections.

## 1.2 Survey of Commercial Software Systems

### 1.2.1 Introduction

Software development programs which are relevant to technology transfer are being carried out by government laboratories, businesses and universities. The various programs are diverse and difficult to categorize. They range from highly focused products for IBM PC's such as IN-SEARCH, e.g., Menlo (1984), to a broad-based program such as the Total Information System (TIS)--a DEC VAX 11/780-based program, e.g., Hampel et al. (1982). The various and sundry programs deal with pre-processing, i.e., a common command language, and post-processing, i.e., abstract sorting, word processing, etc. Both aspects are being considered in the present program, but with emphasis on the personal computer software. The reasons for this emphasis are:

i. The rapid increase in micro-computer capability, e.g., the new IBM AT supports 3 mb of main memory and 40 mb of hard disk memory--all in a desk top unit.

ii. The cost trends. Micro-computer costs have fallen while communications costs have increased. This factor favors distributed computing when compared to a central, i.e., gateway, computer.

iii. The availability of micro-computer software. There is no question that the number of technology transfer oriented programs has increased many-fold in the last year. This is a strong indication of the market trends.

Many of the tasks associated with conducting technology transfer studies are rather mundane--word processing, producing hard copy of abstracts, etc. While these tasks are fairly straight-forward, they are time consuming. A number of commercial software packages can be used effectively in these tasks.

As noted above, the carrying out of technology transfer studies is labor intensive and software systems can significantly improve productivity. A number of appropriate software packages are shown in Figure 2. These are divided into the general categories of pre-processors, gateways, citation analyzers, report writing and text processors. A short description of each program is given in Table 1. There are over-lapping functions among the software systems as well as the lack of any integration among modules.

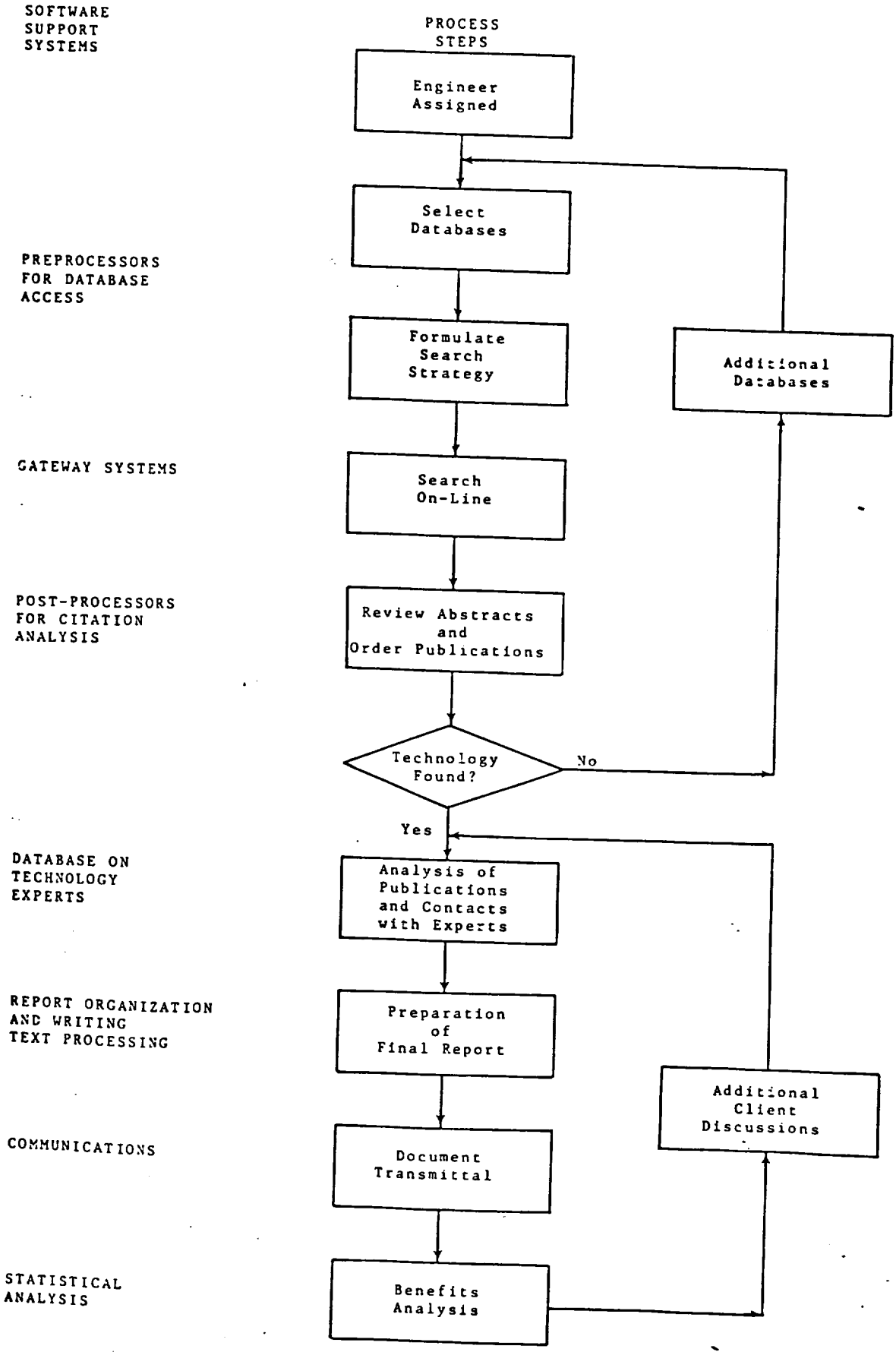



Figure 1. Profile of Steps Carried Out in an Industrial Applications Study

| SOFTWARE SYSTEMS | FUNCTIONAL DATA |
|---|---|
| IN-SEARCH<br>MIST + | Pre-processors for database access |
| Business Computer Network<br>TOTAL INFORMATION SYSTEM | Gateway Systems |
| NUTSHELL | Post-Processor for Citation Analysis |
| dBASE III | Database Program |
| OFFIX<br>THINKTANK | Report Organization and Writing |
| MEMORY/SHIFT<br>TOPVIEW | Integration |
| WORDSTAR<br>SELECT WRITE | Text processing |
| CONNEXUS | Communications |
| STAT-PAK | Statistical Analysis |

Figure 2. Typical Commercial Software Packages for Use in Technology Transfer

TABLE 1
DESCRIPTIONS OF SOME SOFTWARE
SYSTEMS RELEVANT TO TECHNOLOGY
TRANSFER TASKS

| Program Title | Description | Environment(1) |
|---|---|---|
| IN-SEARCH | Front-end database searching program. Catalog of all DIALOG databases and resources. Search revision capabilities and keyword high-lighting within each reference. | IBM PC and compatibles. 192 K; two disk drives; smart or acoustic modem. |
| MIST + | Microcomputer communications program. Program contains a full programming language with specifications for telecommunicating, a database system and a text editor. The data-base can be turned into a full-fledged computer teleconferencing system complete with electronic mail, conferences and on-line databanks. | IBM PC and compatibles. 256 K; two disk drives; hard disk recommended; smart or acoustic modem. |
| Business Computer Network | Logs on automactically to a number of on-line information systems. Program captures text on disk, writes messages off-line, sends them on-line and sends sequences to a printer. | IBM PC and compatibles. 128 K; two disk drives; Hayes compatible modem. |

(1) Minimum equipment requirement. The software vendors are listed in Section 6. 128K denotes 128 kilobytes of main memory. IBM PC/XT or compatibles denotes a 16 bit microcomputer having a 10 Mb fixed disk drive. One disk drive denotes a 320-360Kb removeable disk drive.

TABLE 1 (continued)
DESCRIPTIONS OF SOME SOFTWARE
SYSTEMS RELEVANT TO TECHNOLOGY
TRANSFER TASKS

| Program Title | Description | Environment |
|---|---|---|
| NUTSHELL | Citation analysis system which allows review, categorization, etc. Records can be indexed by title, author, keywords, etc. | IBM PC or compatibles. 128 K; one disk drive; smart or acoustic modem. |
| THINKTANK | Text processing program oriented toward report organization. Uses outlining technique. | IBM PC/XT or compatibles. 256 K; one disk drive. |
| OFFIX | Personal office system which mimics a file cabinet. Software can search a datafile for up to 10 fields simultaneously and then sort by one of the ten. Can also send information to a screen or printer. | IBM PC/XT or compatibles. 256 K. |
| MEMORY/SHIFT | This system allows you to run several programs simultaneously and to transfer data between them. | IBM PC/XT or compatibles. 128 K. |
| TOPVIEW | Provides multitasking and windowing. | IBM PC/XT or compatibles. 512k recommended; one fixed and one removeable disk drive. |

TABLE 1 (continued)
DESCRIPTIONS OF SOME SOFTWARE
SYSTEMS RELEVANT TO TECHNOLOGY
TRANSFER TASKS

| Program Title | Description | Environment |
|---|---|---|
| dBASE III | Database program which constructs and manipulates numeric and character data. Provides database manipulation directly from a keyboard. Provides capability for user-generated menus and application programs. | IBM PC or compatibles. 256 K; two disk drives |
| WORDSTAR | Screen oriented word processing system featuring integrated printing. Displays both initial entry of text and alteration of previously entered text. | IBM PC or compatibles. 128 K; one disk drive. |
| CONEXUS | Communications system providing electronic mail, bulletin boards, teleconferencing, etc. Includes password access system. | IBM PC/XT or compatibles. 256 K; two disk drives; smart modem. |

### 1.2.2 Software Framework for Technology Transfer

The overall program goal is to develop a computer-based "searcher's workstation" of productivity tools for technology transfer as it is done at NASA Industrial Applications Centers and State Technology Assistance Centers. Available packages for this purpose are being evaluated as well as programs developed to meet the needs for which no suitable packages can be found. The main goal is to identify how this capability may be provided on a personal computer (not without precedent, e.g., Bertrand, 1980, or Lefkovitz, 1982).

A model of the "searcher's workstation" is being designed and commercial and/or public-domain offerings identified which can be used to satisfy the modular requirements of the architecture model. That way an individual searcher can select from a list of alternatives to meet a need without having to accept an unchangeable system. For example, the searcher should be able to "plug in" his favorite word-processing program into the system without compromising his access to the other pieces. Or he may choose not to use certain of the "tools in this toolkit" at all.

The online bibliographic database searcher's uses for a computer are summarized in the following sections.

#### 1.2.2.1 User Facility or Common Command Language

The searcher needs a user facility which gives him access to the online systems via telephone communications so that he can

run searches, use the other features of the online system, and download citations. This need as so far described can be met by any of a large number of commercial and public-domain "terminal-emulation programs" which can run on the searcher's local computer.

In addition to this basic capability, it is desirable that the various online database systems be accessible through one common language for specifying searches, downloading citations, and manipulating the resulting files on his local computer. It is possible to obtain this common interface with a program running on the user's local computer. CONIT, Marcus (1982), is the only program which we have found which meets this need adequately, but CONIT does not seem to be moveable from its present, single (large computer) installation. IN-SEARCH is a commercial offering which works with only some databases and is not user-extendible.

1.2.2.2 Reviewing and Determining Relevancy of Abstracts

A large number of citations can result from a single search. It is sometimes a large task to classify these citations as to relevancy or sub-category, e.g., Marcus, (1978),. The TIS GATEWAY, Hampel, et al, (1982), offers some capability in this area in the form of tools for manipulating the abstracts and classifying them. In addition, the TIS GATEWAY offers some unique tools for the analysis of citations by time of publication.

However, USM has found no commercially available automatic or semi-automatic programs for this purpose.

1.2.2.3 Translation of Citation/Abstract Formats

In preparation for presenting the results of the database search to the client, it is sometimes desirable to translate the citations from the various databases into one common format.

1.2.2.4 Organization and Preparation of Report

In the area of writing aids, the offerings on the personal computers have out-paced anything before seen. Outlining, organizing, and word-processing tools abound. The searchers should certainly have this capability.

There is the necessity of converting the files of citations as down-loaded from the online system into a format which can be included into the word-processor. Some word-processors have facilities for doing this; others do not, and it must be programmed.

Ultimately, work in this area may lead to some type of automatic presentation of search results.

1.2.2.5 Special Requirements

This is a miscellaneous category for other search-specific items. The simulation of a sets capability for DTIC's DROLS system is a "special requirement" which needs to be provided for at some time.

#### 1.2.2.6 Utility Needs

Searchers could use their computers for keeping track of their billable time and expenses.

It is convenient to be able to use a word-processor at the same time that you are doing a search or reviewing citations. It may be convenient to use some other two programs together. Utility programs exist to make this possible on some personal computers.

## 1.3 Relevant Commercial Systems

### 1.3.1 User Facility or Common Command Language

IN-SEARCH was mentioned above and is described in Table 1. Unfortunately, IN-SEARCH is limited to DIALOG databases and, at this time, is not user-extendible. IN-SEARCH is the only package in this area which has been found to be useful, but others are becoming available.

One commercial package, MIST+, has been found which might be useable as a base and extended to satisfy this requirement completely. This is being investigated.

### 1.3.2 Reviewing and Determining Relevancy of Abstracts

NUTSHELL is a file manager which has the unique feature of indexing every word in every field. This is useful for determining the relevancy of abstracts in a large group without reading them all. NUTSHELL also allows all the abstracts in the

group to be read from the screen, comments and classifications inserted, and then the updated file search according to the searcher-inserted comments to select out the abstracts of a category.

Other file managers can be used for this purpose, though none has been judged as good or as easy to use as NUTSHELL.

### 1.3.3 Translation of Citation/Abstract Formats

At this point, no suitable commercial programs have been found.

### 1.3.4 Organization and Preparation of Report

A word-processing program is a personal tool, and, so, should be selected by the searcher himself. However, it is important that the one selected have the facility for the inclusion of abstracts. MULTIMATE and SELECT are two which are equipped for this.

The area of outlining and report-organizing tools is a new one. This should be investigated. THINKTANK and OFFIX are two particularly interesting packages of this type.

### 1.3.5 Special Requirements

A commercial database management system may be adaptable (with some custom programming) for the extension of DTIC's DROLS system to allow a set manipulation facility on a personal computer.

### 1.3.6 Utilities

MEMORY/SHIFT, TOPVIEW, or DESQ give the multi-tasking with windows capability. SIDEKICK provides the capability to use its own notewriting program at the same time as another program is running.

There are many commercial file-managers which could be used for recording time and expenses. NUTSHELL can be recommended.

# 2. TECHNICAL APPROACH

## 2.1 Previous Work

### 2.1.1 User Facility and Common Command Language

The investigators have experiemented with a PCCL (Prototype Common Command Language) program. This is a communications program which allows standard database operating commands to be cataloged and called up as macros. The macros are to be supplied by the searcher/user. This program has a menu-based interface. The searcher also designs his menus.

The work with the PCCL program has lead to the development of a database user facility program called DBUF. This program is a combination of a structure editor and a communications program, and allows the user to follow and execute expert-supplied scripts for online database access.

PCCL and the subsequent DBUF are efforts to provide an interface vehicle for online databases which can be tailored to the expertise level of the user, e.g., Carroll, (1984). This is a more general approach than a "Common Command Language." However, both the PCCL and the DBUF programs can serve as delivery systems for prototypes of such a common command language.

### 2.1.2 Reviewing and Determining Relevancy of Abstracts

Previous activities, e.g., Volume II, have lead to the development of SORT-AID, which supports online reviewing of

down-loaded abstracts. Classification categories can be supplied interactively by the searcher.

Abstract relevancy determination tools are being developed. RANK uses lexical association methods from automatic indexing to rank abstracts. A hypertext system is used to facilitate manual reviewing and classification of abstracts. These tools allow relevancy determination to be carried out in a manual, semi-automatic or automatic mode, with more or less reliance on the computer, as the searcher chooses, and as his particular search justifies.

### 2.1.3 Translation of Citation Formats

The SORT-AID system contains a PRINT module. PRINT supports selection and reformatting of abstracts for printing. Reformatting includes re-justification, re-pagination, and transformation of keywords and content.

### 2.1.4 Organization and Preparation of Reports

It is intended that commercial word-processors be used with the searcher's workstation. However, DBUF provides elementary word-processing with outlining and wordwrap facilities.

### 2.1.5 Special Requirements

A set manipulation capability tailored to DTIC's DROLS system would be a desirable future addition to the searcher's workstation.

### 2.1.6 Utility Requirements

TOPVIEW and/or MEMORY/SHIFT can possibly provide some multi-tasking capability.

## 2.2 SORT-AID Post-Processor

The SORT-AID system is a set of programs designed to be used by an engineer/researcher in the preparation of industrial applications studies. The SORT-AID system is designed to be useful in that interim stage in report preparation after the database querying and searching have been completed and before the actual writing process begins. Accordingly, SORT-AID provides facilities for classifying, manipulating, and organizing the abstract/citation files resulting from online database searching.

SORT-AID 2.1 is a set of four programs written in FORTRAN 77. SORT-AID 2.1 is a complete re-coding of SORT-AID 2.0. This re-coded version includes all of the features of the older version. In addition, it allows the user to delete citations, create citations or notes, and reorder the citations within the file. Major improvements in disk storage utilization and execution speed are achieved with this new version.

Sort-Aid 2.1 is demonstrated to be portable by implementations on the DEC VAX 11-78, IBM-PC, and UNIVAC, e.g., Vital (1985).

### 2.2.1 Description of Operation of Program: NABST

Figure 3 shows the system flow for the SORT-AID system. Input is the individual files resulting from multiple database searches. These files are combined by the NABST program. After the combined file is created by NABST, it can be accessed immediately by the user with the REVIEW program. Optionally, an automatic or semi-automatic relevance ordering can be created for the combined citation file with the RANK program. After the abstract/citations in a combined file have been classified by the user into report-specific categories, they can be printed according to those categories with PRINT.

NABST must be run for each abstract/citation file which has been downloaded from a bibliographic database system. For the first such file from a search, when NABST prompts the user for whether it is a new combined file or not, the correct response is that it is. For each subsequent file, the correct response is that is not. The created combined file's name is "ABS" followed by the search identifier, which can be up to five alphanumeric characters beginning with an alphabetic, followed by ".DAT".

In addition to the abstract/citation file, NABST requires for input a "DELIM.DAT" file. This file is created with the system editor and contains images of the delimiters which may appear in the input abstract/citation files to mark the beginnings of abstract/citations. Each image is in a separate record in this file. The first two characters of the record are

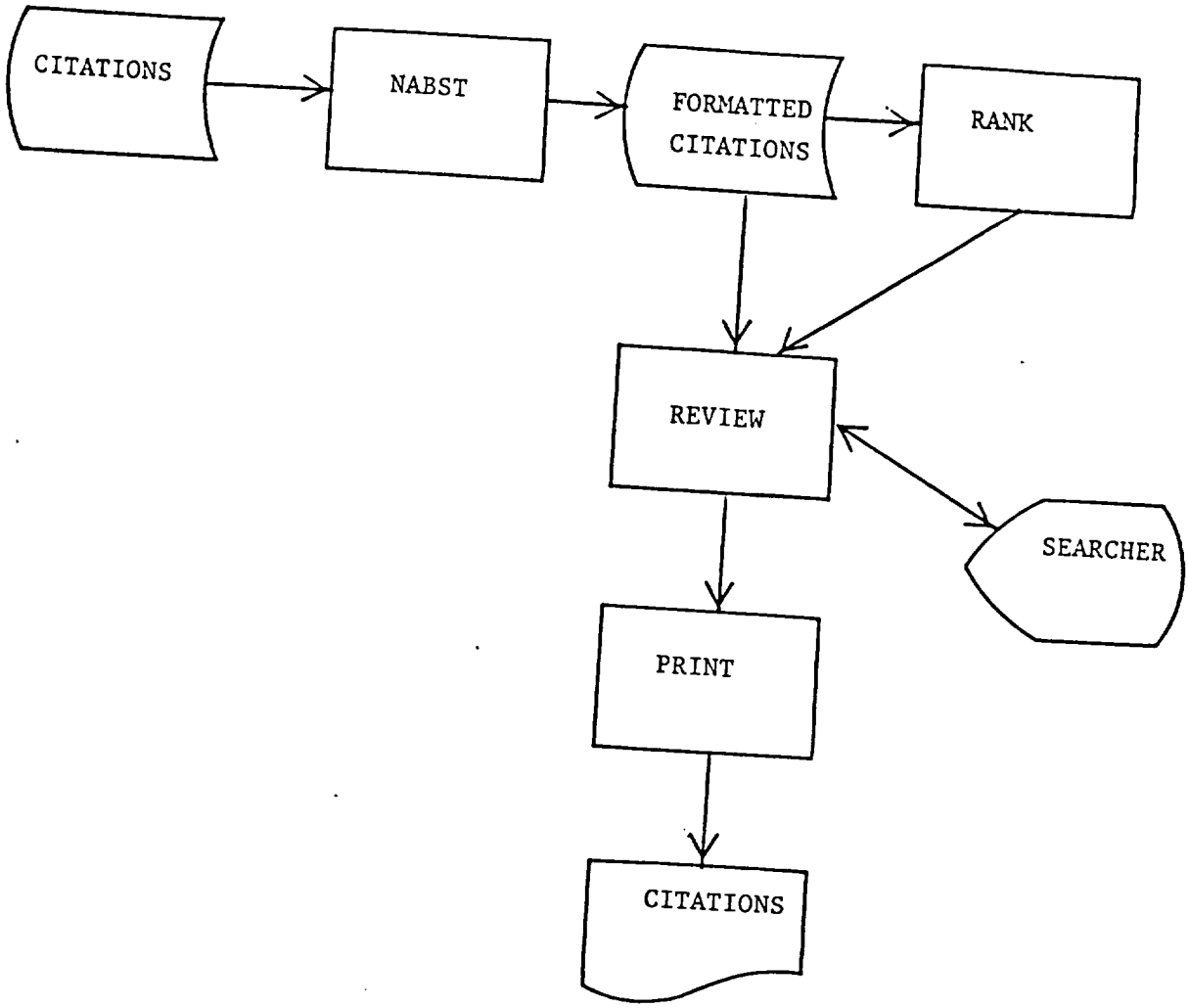



FIGURE 3: System Flow of SORT-AID 2.1.

used for the length of the image in characters. The rest of the record is used for the image. The character "N" is used in the image to signify any numeric digit. For example, if the abstracts downloaded from a particular database contain "XYZ" followed by any two digit number at their beginnings the record in DELIM.DAT representing this would be:

05XYZNN

In addition to the combined abstract/citation file, NABST creates a lexical statistics file which is used by RANK. This file's name is "STA" followed by the search ID followed by ".DAT".

### 2.2.2 Description of Operation of Program: REVIEW

REVIEW reads the combined abstract/citation file and allows the engineer/searcher to review the contents in its created order or according to a "relevance" order as determined by the RANK program. Optionally the abstracts may be reviewed in the order they were received. The abstracts are presented in the format they were received in (at the request of the users of the system).

REVIEW asks the user which of several allowed for terminal types he is using. If the user has none of the types on the list, he should answer that he has teletype capability, which is one of the choices. The only use for this terminal information in REVIEW is to fill the screens from the top down rather than having them scroll from the bottom. This allows reading to begin immediately.

REVIEW is command-driven. Sort-Aid 2.0's version of REVIEW was menu-driven. Users wanted it to be command-driven. Also, the addition of more functions in this version make a menu clumsy. The facilities offered are:

i. Proceed to next screen, which will be more of a multi-screen entry, or to the next entry.

ii. Set abstract category, which allows the operator to assign a report-specific category or categories to be carried in the file with the citation. This category can be any character string without spaces or commas. Multiple categories are entered with commas in between and no spaces.

iii. Go directly to the next abstract.

iv. Go to the beginning of the current abstract.

v. Go directly to an abstract in the file addressed by its relative position in the file.

vi. Back up one abstract in the file.

vii. Search on the occurrence of an entered string. This is useful for finding entries containing a particular word, phrase, or author name, for example.

viii. Set search category; this allows the user to only see entries which have been previously set to a certain category or categories; "*" shows all categories, including un-categorized entries.

ix. Delete an entry from the file.

x. Enter notes into the file as a discrete entry; this entry can be categorized and processed like the others.

xi. Re-order an entry; this may be used to place a particularly interesting entry at the beginning of the file; or an uninteresting one at the end; this is done for the physical and the "relevance" orders.

xii. Load an internal memory register with the relative position of the current abstract.

xiii. Return to the abstract pointed to by the internal memory register.

xiv. Stop processing.

REVIEW is designed to allow the searcher to review and categorize abstracts until he has enough for his report, at which time he can stop processing. It also allows categorization to proceed iteratively via stepwise refinement; that is, the searcher can go through the file once applying gross categories, and then begin at the beginning looking at only a single gross category, applying finer categories.

### 2.2.3 Description of Operation of Program: RANK

RANK may be executed after the combined abstract file is completely created by NABST. RANK creates a file which contains a record for each abstract in the combined file. Each record contains the relative position of its associated abstract. These records are ordered in decreasing order by a "relevance" score.

To create the "relevance" score, RANK chooses two sets of thirty words each and displays them to the user. The user can delete words from this set. The words are selected so as to represent the set of abstracts in the combined file. The user deletes those words which do not apply to the intended subject of his search. Using this information RANK can calculate a "relevance" score. Also, the searcher can terminate a search at any time and resume it later if he remembers the relative

position of the abstract in the file. This relative location number appears on the REVIEW screen.

In addition to the combined citation file, RANK requires a "stop list" file as input. This file contains common words which cannot have report-specific meaning such as "a", "an", "and", and so forth. This file is created with the system editor with one word in each record beginning in the first position. The file is named "STOP.DAT".

### 2.2.4 Description of Operation of Program: PRINT

PRINT is used to include abstracts of particular categories in a report. The format of the abstracts may be changed, i.e., Chen (1985), and the page length and width may be specified. The abstracts are included in the "relevance" order or in physical order. PRINT is invoked by a command in the REVIEW program. Selection of abstracts for inclusion in the PRINT report follows the conventions set up in REVIEW.

## 2.3 Abstract Relevance Determination

Abstract relevance determination is a unique requirement of a searcher's workstation. The optimal approach is to develop several tools which the searcher can choose according to his/her tastes and needs. One tool is the REVIEW program in SORT-AID, which allows the examination of each citation and a manual ranking/classification to be done.

Integrated with REVIEW in the SORT-AID system is the RANK program. RANK can order the abstracts according to its own measure of relevance. The searcher can then REVIEW these abstracts in the order, most relevant first, supplied by RANK.

Another tool, which exists now only as a PC-based prototype, is "hypertext"-derived. "Hypertext" refers to a multi-threaded indexing scheme for text. The USM system builds such a data structure for the down-loaded abstracts and allows the searcher to peruse them by navigating with terms.

### 2.3.1 Theory of Relevance Determination: RANK

The RANK program uses a method for semi-automatic relevance determination based on the lexical association methods of automatic indexing, i.e., Salton, (1975). This automatic indexing theory is applied to the abstract/citations which are already the result of a search, rather than to a collection as a whole, which is the context for which it was developed. This "post-search" collection is comprised of abstract/citations of a homogeneous nature, as it is the product of a single query or related set of queries. This homogeneous nature of the collection accentuates the characteristics of the automatic indexing methods. The RANK program exploits this accentuation.

The method of relevance ranking employed may be considered to be similar to the keyword querying. However, the keywords are not selected from a controlled vocabulary of the database system, but from lists generated with automatic indexing

algorithms applied internally to the "post-search" collection. The user is allowed to select his "query" keywords from these lists. The abstracts in the collection are ranked for relevance by the frequency of occurrence of these query keywords.

RANK presents two lists of automatically generated keywords to the searcher. The first list is based on collection frequency. This list contains the thirty most frequent words in the set of abstracts--which are not on the stop list. The user is allowed to mark which of these have high relevance to his problem. The second set of keywords is based on a signal-to-noise statistic. The user is allowed to mark which of these have high relevance to his problem. In determining a "relevance score" for each citation in the combined file, the score is increased by one for the presence of a collection frequency keyword marked relevant by the user, and is decreased by one for each signal-to-noise keyword NOT marked relevant by the user.

Indexing methods based on collection frequency have been found to produce high recall, but with low precision. Indexing methods based on signal-to-noise ratio produce precise output, but with lower recall. This method of semi-automatic relevance determination used in RANK combines the best features of these two methods.

REVIEW allows the user to consider the entries for classification in descending order of relevance score. This implies that the user can terminate reviewing when, in his

judgement, he has found enough material for his report and have some assurance that he has not overlooked many relevant entries. The savings is in how many abstract/citations this method allows him not to review. (To enforce such an economy, a cut-off score might be set and implemented in the programs, but this is not done now.)

### 2.3.2 Evaluation of Relevance Determination: RANK

With a test set of eight searches, the method used in RANK with no user determination of the relevance of the keywords has been found to be effective. This amounts to using RANK in a totally automatic mode. Used in this way, the number of entries considered to be relevant in the top ten selected by RANK is consistently 10 to 20% better than what would result from a random selection; the number of entries considered to be relevant in the top fifty selected by RANK is consistently 5 to 10% better than what would result from a random selection.

Currently, the potential of the method used in the semi-automatic mode (with user designation of relevant keywords) is being investigated. Theoretically, this mode can very powerful, especially if used with the engineering-style objective of finding a small number of acceptable citations, and not establishing too high a regret on missing some in the process.

### 2.3.3 Hypertext

Hypertext is an old idea, e.g., Bush, (1945). Only recently with the advent of inexpensive, powerful microcomputers

has the idea become nearly practical for application, e.g., Price, (1982), or Weyer, (1982).

A "hypertext" is an augmented text file. The augmentation consists of indices of the occurences of ideas, concepts, phrases or words. An automatically generated hypertext must involve words or phrases at this time, until artificial natural language techniques reach the ability to identify ideas or concepts.

The USM hypertext experimental program, e.g., Howard (1985), generates a hypertext referencing all the words in a set of abstracts. The navigation module permits the searcher to identify words in an abstract and then to follow the occurence of that word through other abstracts. The searcher may change the word of interest at any time. This offers an avenue for a quick identification of a set of abstracts which references a particular word or set of words.

## 2.4 Database User Facilities

The USM approach to a searcher's workstation is an example of a "fourth-generation" approach to computing. This "fourth-generation" approach involves the identification of a canonical set of components and using those components as building blocks for systems, e.g., ANSI, (1984), and CODASYL, (1978). The desirable components for a searcher's workstation are being identified in order to make them available to database searchers. The searchers can select from this set those that fit their needs.

A "database user facility" is a classical fourth-generation component. As database management systems have evolved, they have shown greater and greater functionality to the user. Some of that functionality, i.e., terminal-specific functions such as graphics and lightpens, could be handled more effectively if they were isolated logically from the database management system itself. This approach resulted in specific software components, which can be termed "database-user facilities."

The USM user facility work has centered on placing appropriate extra-database system functionality in a personal computer on the searcher's desk. This functionality includes aspects of a command language along with the usual communication functions such as down-loading citation files.

A search for instances of the "user facility" found the systems: CONIT (Marcus, 1982), DIVERSE (Hambeigner, 1984), IN-SEARCH (Menlo, 1984), NAM (Treu, 1982), and ZOG (Robertson, 1980).

### 2.4.1 Problem Statement

There are many bibliographic citation databases available to computer terminal equipment over telephone lines. These databases are useful for technological research and the development of bibliographies. Usually, for a researcher to use these databases, he must seek the assistance of an "expert

intermediary" who specializes in the details of online searching and knows the command languages of the different systems.

A program goal is to design a user-interface for these information retrieval systems which achieves a common command language for several databases. This user-interface could reside in a personal or timeshared computer which is to act as a "gateway" to the bibliographic database systems. This user-interface is to mediate the dialog between the user and the online systems. This system could function in a menu-based manner. Integral help facilities are desirable. An important feature is that user extension be allowed.

The system should have modes of usage for expert and non-expert users. There are many subtleties of using the various databases that are not apparent in the manuals. Developing truly equivalent commands which remain equivalent across several databases may not be possible. However, before searching can be done by non-experts, this must be accomplished. One way that this work can be done is to provide the expert searchers with a vehicle to codify and verify such efforts.

### 2.4.2 PCCL Program

USM's first experiments were with a program called PCCL (Prototype Common Command Language). PCCL allows the building of custom menus and the providing of down-loadable command sets which can be called up by those menus. The menus and the associated command sets are accessible to the user.

Using PCCL, example menus were set up for common searching functions. The menus appeared the same to the user, but had different command sets underneath depending on the database system which was the target. Thus, template commands could be prepared by an expert searcher, coded into the PCCL format, and given over to a less-expert user for execution.

The PCCL program demonstrated the value and feasibility of removing the syntax barrier. The program also established the idea of the preparation of these "canned query templates" by an expert, who is familiar with the nuances of the databases of interest and with the purposes of the specific less-expert user.

### 2.4.3 DBUF Program

The problem with the PCCL framework was that it was difficult to build enough intelligence into the command sets to accomplish more than the most rudimentary operations. Also, there was little tutorial value to using the program. The DBUF (DataBase User Facility) program was developed to alleviate the PCCL shortcomings and to extend the PCCL strengths.

DBUF is a combination between a screen-oriented, structured-text editor and a communications program. Text may be entered and structured in outline form. It may be viewed at any level in the outline. Specific lines in the text may be designated for communication down the phone line. Before communication, those lines may be changed temporarily.

DBUF allows an expert searcher to develop "scripts" of particular examples of the searching process. These scripts may be indexed and outlined using structure editor features. These scripts can contain descriptions, rationales, specific command lines, aphorisms, and other searching wisdom.

The user can search his scripts for the one that applies to his problem and then follow it, modifying commands as required, and sending the appropriate commands down the line to the online database system.

Scripts can be developed and traded. An expert searcher who is not familiar with a new database might request a script from a colleague who is familiar with that database. Scripts might be catalogued by NASA and stored on a database for retrieval like citations. Scripts can be classified for novices, journeymen searchers, and so forth.

In this manner the DBUF can be the basis for a common script command language. Parallel scripts can be developed for all of the database systems. Searchers can follow the scripts and beware the signposts and lookouts embedded in the scripts for the particular databases. In following the scripts the user gains expertise.

More expert users can develop their own shorthand note scripts. Expert users can publish and trade scripts.

## 2.5 Proposed Continuation of Work

### 2.5.1 PC-Based Evaluation Systems

As described in Section 2.6.1, following, it is proposed the basic searcher's workstation be installed in selected NASA sites. This requires documentation, the building of adequate control table files and scripts, and the optimization of the system for performance, as well as installation and continuing support.

### 2.5.2 Hypertext Experiments

The hypertext experiment was promising enough to consider. A string-processing board for the PC has been obtained--this is a new development--and should make hypertext viable from the processing time point of view.

The use of hypertext for determining relevancy needs to be related to the other relevancy determination tools in the workstation. A version of hypertext needs to be integrated into SORT-AID to be included in the evaluation system.

This hypertext offers other potentials in information retrieval. One would be a delivery method for a library card catalog.

This hypertext work is strictly exploratory. No formal evaluation is planned.

### 2.5.3 PROLOG Experiments

Programming in Logic (PROLOG) is a recently developed technique for knowledge representation in artificial

intelligence. PROLOG offers unique possibilities for information retrieval, and especially in the abstract relevancy determination problem.

Using the abstract format transformation facility developed in the PRINT module of SORT-AID, certain abstract fields can be automatically translated using PROLOG. If this is done for a down-loaded search set, PROLOG deductive and inferencing querying capabilities can be employed for selecting the relevant abstracts.

This is another exploratory initiative.

### 2.5.4 Executable Documentation

The DBUF methods for "scripting" can be extended to provide "executable documentation." The user manuals for the online database systems are usually replete with example commands. If the complete texts of the manuals were rendered machine-readable and a suitable structure applied (possibly automatically), they could serve as scripts in DBUF. This offers exciting potential for opening up the database systems to more users.

There is some recent activity in this area in the literature, e.g., Bramwell, (1983), Rouse, (1980), and Witten, (1985).

### 2.5.5 A "Search Value Coefficient"

Dr. Dan Wilde, (1984), pointed out that the lexical association methods employed in RANK might be pursued to yield a

"search value coefficient". This would be a number which would score a search as to homogeneity and variety of its constituent abstracts. Hypothetically, a number too large or too small might indicate that the search needs to be re-done.

This possibility will be explored in the coming year.

## 2.6 Scope of Work

### 2.6.1 Work Statement

The NASA Technology Utilization office in conjunction with the University of Southern Mississippi has supported the development of a number of software tools which aid in the practice of technology transfer. The technology transfer process includes problem definition, bibliographic database searching, analysis of abstracts and/or full text documents, consultation with relevant experts and preparation of a final report. The software tools support all of these activities to a greater or lesser extent with primary emphasis on the analysis of abstracts. The continuation of activities is principally focused on completion of the abstract analysis systems known as SORT-AID and DBUF. SORT-AID determines the relevance of abstracts to a specified problem statement using lexical association techniques as a knowledge base and a series of artificial intelligence frames.

The basic items of work to be accomplished in the continuation program are:

i. Reconfiguration of all SORT-AID algorithms--currently operational on a DEC VAX 11-780--for operation on an IBM-XT or compatible microcomputer. A string comparison coprocessor is now available for the IBM PC and will be employed in the development program. The coprocessor should significantly reduce program execution times. The reconfiguration will involve significant assembly language coding to insure compatibility with the coprocessor. Abstract relevance determination experiments will be continued utilizing lexical association, hypertext, PROLOG and the search value coefficient.

ii. Continued development of the database user facility common command language. These algorithms are currently operational on a micro-computer and activities will be limited to user suggested refinements.

iii. Extension of capabilities for the DBUF algorithms. The DBUF methods for scripting search strategies will be extended to include limited executable documentation.

iv. Integration of SORT-AID and DBUF. SORT-AID--when completed--and DBUF will be integrated to provide a fully functional searcher's workstation.

v. Software documentation. All software furnished to the NASA IAC's and STAC's will be user-friendly and documented to a standard compatable to commercially-available software.

vi. Installation and initial software testing. The prototype searcher's workstation software system will be installed at three NASA technology transfer facilities during the coming year. Each site must provide a suitably configured 16-bit microcomputer using an MS-DOS operating system. Hardware specifications will be provided. The minimum hardware environment is expected to include: 512Kb main memory, 10Mb fixed disk drive, 360Kb removable disk drive, 1200 baud modem, string comparator coprocessor, and a graphics printer or suitable output device.

During the testing period, USM will provide complete software support. The test facilities

will be expected to monitor system performance, log and/or record problems and generally offer suggestions with regard to the system performance.

vii. Software Modifications. Following reports and/or comments by the three test sites, limited revisions to the software system will be made.

viii. Liaison with Other NASA Information/Technology Transfer Organizations. USM personnel will continue liaison activities with other NASA funded programs on a time-available basis.

ix. Reporting. Three quarterly reports and a final report will be provided.

### 2.6.2 Schedule

The schedule for the aforementioned tasks is shown in Figure 4. The schedule is realistic and is consistent with the funding available.

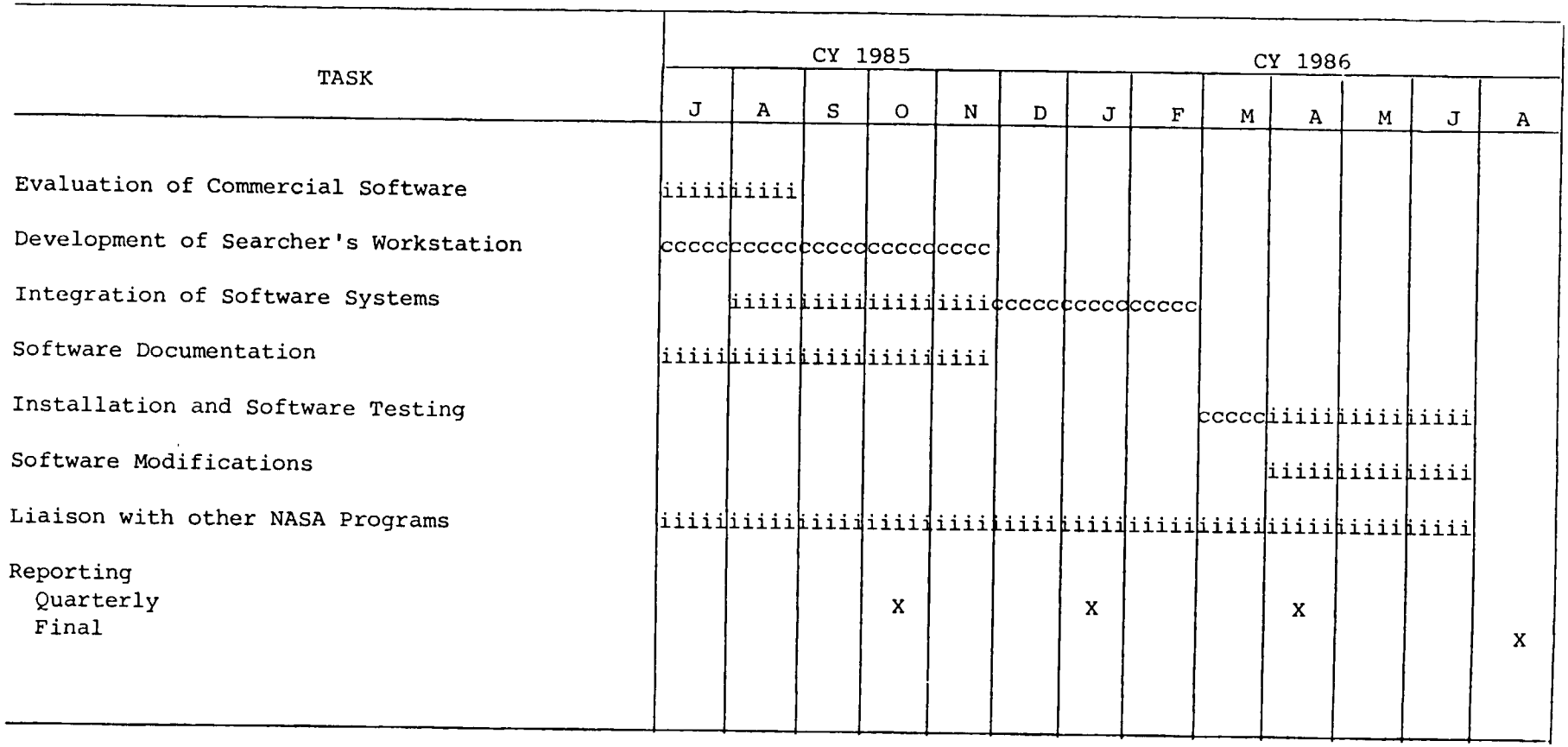
### 2.6.3 Budget

The program budget is shown in Table 2. The total program cost is $100,040 with USM providing $26,200 in cost sharing. The net cost to NASA is $73,840.

### 2.6.4 Summary

Technology transfer activities are carried out by NASA via a network of Industrial Applications Centers and State Technology Assistance Centers. These organizations employ a number of modes of technology transfer which principally vary in degree of specificity. These modes are largely the same regardless of the technology under consideration. These processes

are labor intensive and are now being automated using micro-computer-based techniques and software support systems. The software support systems encompass pre-processors for database access, gateway systems, post-processors for citation analysis, report organization and writing, text processing, communications, and program integration. Much of the above software is commercially available with the citation analysis algorithms under development at USM. Integration of the software modules is also in the early development stages with continuing activities proposed. All in all, the full implementation of the software systems can reduce technology transfer study costs by up to 15%.



| TASK | CY 1985 | | | | | | CY 1986 | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | J | A | S | O | N | D | J | F | M | A | M | J | A | |
| Evaluation of Commercial Software | iiiii | iiiii | | | | | | | | | | | | |
| Development of Searcher's Workstation | ccccc | ccccc | ccccc | ccccc | ccccc | | | | | | | | | |
| Integration of Software Systems | | iiiii | iiiii | iiiii | iiiii | ccccc | ccccc | ccccc | | | | | | |
| Software Documentation | iiiii | iiiii | iiiii | iiiii | iiiii | | | | | | | | | |
| Installation and Software Testing | | | | | | | | | ccccc | iiiii | iiiii | iiiii | | |
| Software Modifications | | | | | | | | | | iiiii | iiiii | iiiii | | |
| Liaison with other NASA Programs | iiiii | iiiii | iiiii | iiiii | iiiii | iiiii | iiiii | iiiii | iiiii | iiiii | iiiii | iiiii | | |
| Reporting | | | | | | | | | | | | | | |
| Quarterly | | | | X | | | X | | | X | | | | |
| Final | | | | | | | | | | | | | | X |

LEGEND: Continous: c
Intermittent: i

Figure 4. Program Schedule

TABLE 2
PROGRAM BUDGET

| Personnel | NASA | USM (1) | TOTAL |
|---|---|---|---|
| G. David Huffman, 3mm | 12,200 | 4,300 | 16,500 |
| W. Leigh, 6mm | 16,367 | 11,497 | 27,864 |
| Research Assistant, 6mm | 6,000 | | 6,000 |
| Part-time Secretarial | 3,000 | | 3,000 |
| Subtotal | 37,567 | 15,797 | 53,364 |
| Fringe Benefits | 5,466 | 2,915 | 8,381 |
| Miscellaneous | | | |
| Software | 500 | | 500 |
| Travel | 7,000 | | 7,000 |
| Subtotal | 7,500 | | 7,500 |
| Equipment | 5,500 | | 5,500 |
| Indirect Costs (47.4% of Salaries) | 17,807 | 7,488 | 25,595 |
| Total | 73,840 | 26,200 | 100,040 |
| Grand Total | 100,040 | | |

(1) USM Cost Sharing.

# 3. PERSONNEL

## 3.1 Overview

The program will be conducted by Drs. Huffman and Leigh with the support of Mr. Dennis Vital. Administrative support will be provided by Misses D. Theisen and T. Saucier. Drs. Huffman and Leigh have over 40 years of combined experience in software development. Their experience has been in both universities and industry and spans a broad spectrum of activities, i.e., real-time software for process control to management information systems. Drs. Leigh and Huffman conceived the technology transfer workstation and have worked on the project since its conception. Mr. Dennis Vital has provided programming and software design support and is expected to continue on the project through December, 1985. Resumes of all individuals are listed in the following sections.

## 3.2 Resume for G. David Huffman

PERSONAL DATA


Office: College of Science and Technology
The University of Southern Mississippi
Southern Station, Box 5165
Hattiesburg, MS 39406
Telephone (601) 266-4883

Residence: 902 Sioux Lane
Hattiesburg, MS 39401
Telephone (601) 264-6137


EDUCATION

| | |
|---|---|
| 1970 | Postdoctoral research, Imperial College of Science and Technology, London, England |
| 1968 | Ph.D., Mechanical Engineering, The Ohio State University, Columbus, OH |
| 1966 | M. Sc., Mechanical Engineering, The Ohio State University, Columbus, OH |
| 1962 | B. Engr. Sc. (cum laude), Engineering Science, Marshall University, Huntington, WV |

PROFESSIONAL EXPERIENCE

| | |
|---|---|
| August 1984 - Present | Dean of the College of Science and Technology and Professor of Computer Science, The University of Southern Mississippi, Hattiesburg, MS |
| December 1983 - July 1984 | Professor and Chairman, Department of Computer and Information Science Purdue University School of Science, Indianapolis, IN<br>Chief Scientist, Indianapolis Center for Advanced Research<br>Adjunct Professor of Engineering, Purdue University School of Engineering and Technology, Indianapolis, IN |

| | | |
|---|---|---|
| August 1974<br>August 1984 | - | Director, Energy Engineering and Research Division, Indianapolis Center for Advanced Research and Professor of Computer Science, Purdue University School of Science, Indiana University-Purdue University at Indianapolis, IN |
| July 1978<br>June 1979 | - | Distinguished Visiting Scientist, Department of Aeronautics, U.S. Air Force Academy, CO |
| June 1974<br>August 1974 | - | Chief, Mechanics Research, Detroit Diesel Allison Division, General Motors Corporation, Indianapolis, IN |
| Sept.1970<br>Sept. 1972 | - | Principal Scientist, Experimental Fluid Mechanics Research, Detroit Diesel Allison Division, General Motors Corporation, Indianapolis, IN |
| Sept. 1968<br>Sept.1970 | - | Section Chief Research Department, Detroit Diesel Allison Division, General Motors Corporation, Indianapolis, IN |
| March 1962<br>August 1965 | - | Research Engineer, U.S. Air Force Aero Propulsion Laboratory, Wright-Patterson AFB, OH |

## 3.3 Resume for William E. Leigh

PERSONAL DATA


Office: Department of Computer Science and Statistics
College of Science and Technology
The University of Southern Mississippi
Southern Station, Box 5165
Hattiesburg, MS 39406
Telephone (601) 266-4949

Residence: 10 Alexander Drive
Hattiesburg, MS 39401
Telephone (601) 264-5692


EDUCATION

| | |
|---|---|
| 1984 | Ph.D., Information Systems, University of Cincinnati, OH |
| 1974 | MBA, Industrial Management, University of Cincinnati, Cincinnati, OH |
| 1973 | M.S., Computer Science, Rensselaer Polytechnic Institute, Troy, NY |
| 1968 | B.S., Mathematics, Millsaps College, Jackson, MS |

PROFESSIONAL EXPERIENCE

| | |
|---|---|
| August 1984 Present | - Associate Professor Computer Science, The University of Southern Mississippi, Hattiesburg, MS |
| December 1983 August 1984 | - Assistant Professor Computer and Information Science, Indiana University-Purdue University at Indianapolis, IN |
| August 1979 December 1983 | - Assistant Professor Information Systems, Northern Kentucky University, Highland Heights, KY |
| January 1975 August 1979 | - Consultant,Data MethodsCorporation, Cincinnati, OH |

September 1973 - Director of Information Systems, Ambulatory Patient Care, Inc., Cincinnati, OH

October 1971 - Systems Engineer, IBM Corp., Cincinnati, OH
September 1973

January 1969 - Programmer-Analyst, IBM Corp., Kingston, NY
October 1971

## 3.4 Resume for Dennis Vital

PERSONAL DATA

| | |
|---|---|
| Office: | Southern Station Box 7126<br>Hattiesburg, Mississippi 39406 |
| Residence: | 208 1/2 N. 22nd Avenue<br>Hattiesburg, Mississippi 39401 |

EDUCATION

| | |
|---|---|
| 1986 | M.S., University of Southern Mississippi, Computer Science |
| 1983 | B.S., Computer Science, University of Southern Mississippi |

WORK EXPERIENCE

| | |
|---|---|
| July 1984 Present | - Research Assistant |
| September 1980 May 1984 | - Student Assistant Banquet Manager, University of Southern Mississippi, Food Service Department. |

## 3.5 Resume for Deborah A. Theisen

PERSONAL DATA

Office: College of Science and Technology
University of Southern Mississippi
Southern Station Box 5165
Hattiesburg, Mississippi 39406

Residence: 103 Ross Blvd., Apartment A-2
Hattiesburg, Mississippi 39401

EDUCATION

Present — Pursuing a degree in Business Administration, UniversityofSouthernMississippi, Hattiesburg, Mississippi

1975 — Diploma - Pascagoula High School, Pascagoula, Mississippi

WORK EXPERIENCE

August 1985 Present - Office Manager of the Dean's Office, College of Science and Technology

August 1983 July 1985 - Secretary, Department of Engineering Technology, University of Southern Mississippi, Hattiesburg, Mississippi

January 1981 May 1982 - Teacher's Aide - Special Education, Hattiesburg Public School System, Hattiesburg, Mississippi

July 1979 August 1980 - Electrical Apprentice, Ingalls Shipbuilding, Litton Industries, Pascagoula, Mississippi

October 1976 June 1979 - Secretary, Ingalls Shipbuilding, Litton Industries, Pascagoula, Mississippi

## 3.6 Resume for Terri L. Saucier

PERSONAL

Office: College of Science and Technology
University of Southern Mississippi
Southern Station Box 5165
Hattiesburg, Mississippi 39406

Residence: 3021 Highway 49 N
Windsor Village Apartments, #62
Hattiesburg, Mississippi 39401

EDUCATION

May 1984 Diploma - Mississippi Gulf Coast Junior College, Perkinston Campus, Perkinston
Major: Secretarial Science

May 1982 Diploma - East Central HighSchool, Hurley, Mississippi
Rank in Class: Top 10%

WORK EXPERIENCE

June 1985 - Present - Secretary - Dean's Office, College of Science and Technology, University of Southern Mississippi, Hattiesburg, Mississippi

January 1985 - May 1985 - Marine Claims Assistant, Waterman Steamship Corporation, Dandale Drive, Mobile, Alabama

May 1984 - December 1984 - Statistical Typist/Secretary, Dravo Natural Resources Company, McDuffie Island, Mobile, Alabama

May 1983 - August 1983 - Secretary, Marine Sales and Service, Inc., Frederic Street, Pascagoula, Mississippi (Summer Employment)

May 1982 - January 1983 - Secretary, Marine Sales and Service, Inc., Frederic Street, Pascagoula, Mississippi (Part-time Employment)

# 4. OPERATING ORGANIZATION

## 4.1 The University of Southern Mississippi

The University of Southern Mississippi was established by an act of the Legislature approved on March 30, 1910, by Governor Edmund E. Noel. Its first name was the Mississippi Normal College, and its original purpose was to train teachers for the rural schools of Mississippi.

The act of March 30, 1910, did not provide any state money for the building of Mississippi Normal College, but did provide that localities in the state might bid for its location by offering land for a site and money for constructing buildings. On September 16, 1910, the Board of Trustees accepted the bid of Hattiesburg and Forrest County to supply $250,000 and a free site. That site was west of the city in cut-over timberland with great pine stumps everywhere. Contracts were let to clear the land and to build buildings.

The five permanent buildings (College Hall, Forrest County Hall, Hattiesburg Hall, the Industrial Cottage, now the Honor House, and the President's Home, now the Alumni House, a temporary wooden Dining Hall) and other necessary improvements were barely finished when the Mississippi Normal College opened on the rainy morning of September 18, 1912, with a president, a faculty of eighteen, and a student body of 200.

On October 17, 1911, Joseph Anderson Cook, Superintendent of Schools, Columbus, Mississippi, was elected president. The

University of Southern Mississippi has had only six presidents during the more than seventy years since its founding. The Board of Trustees elected Claude Bennett president effective October 10, 1928. On April 23, 1933, the Board of Trustees elected Dr. Jennings Burgon George as the third president, effective July 1, 1933. On June 13, 1945, the Board of Trustees elected Dr. Robert Cecil Cook as the fourth president and he officially assumed office on July 1, 1945. On October 21, 1954, President Cook submitted his resignation. He served until December 31, 1954, and Dr. Richard Aubrey McLemore became acting president on January 1, 1955. The Board of Trustees, on May 19, 1955, elected Dr. William David McCain as the fifth president. He officially assumed office on August 1, 1955, and retired as of June 30, 1975. Dr. Aubrey Keith Lucas became the sixth president of the University on July 1, 1975.

As has been stated, the University of Southern Mississippi was founded on March 30, 1910, as the Mississippi Normal College. On March 7, 1924, the Legislature changed the name to State Teachers College. On February 8, 1940, the Legislature changed the name to Mississippi Southern College, and on February 27, 1962, the Legislature changed the name to the University of Southern Mississippi.

The Mississippi Normal College did not grant degrees in its early years, but awarded certificates for the completion of certain specified courses of study. On April 8, 1922, the

Legislature authorized the awarding of the Bachelor of Science degree. The Bachelor of Music degree was authorized by the Board of Trustees on June 19, 1934. The first Bachelor of Arts degree was awarded on August 20, 1940. On May 26, 1947, the Board of Trustees of State Institutions of Higher Learning authorized the initiation of graduate work and the awarding of the Master of Arts. Doctoral programs were first authorized by the Board of Trustees on May 20, 1959. Numerous other degree programs have been authorized during the past twenty-six years.

The administrative and academic organization of the University of Southern Mississippi is basic and relatively simple. This reorganization took place in 1982. The executive Vice President coordinates the offices of the Vice President for Academic Affairs and the Vice President for Research and Extended Services. The Vice President for Business and Finance is in charge of all financial operations of the University. The Vice President for Student Affairs is responsible for the welfare of the student body, and the Director of Intercollegiate Atheletics is in charge of the atheletic programs.

The academic area of the University of Southern Mississippi is organized into the College of Business Administration, the College of Education and Psychology, the College of Fine Arts, the College of Liberal Arts, the College of Science and Technology, the Honors College, the School of Health, Physical Education and Recreation, the School of Home Economics, the

School of Library Service, the School of Nursing, the Graduate School of Social Work, the Graduate School, and the Division of Continuing Education.

The number of graduates is some measure of the growth of a university. The University of Southern Mississippi has awarded 56,606 degrees since the first one was conferred in 1922.

Research has been strengthened at the University of Southern Mississippi in several ways; the number of doctoral degrees has been increased; the University has established its own scholarly journals The Southern Quarterly and The Education and Psychological Research Journal; the Computing Center has been equipped to expedite contracts and faculty research; the Office of Research and Sponsored Programs has been established by the University to promote research and to assist faculty members in their research activities; and the University of Southern Mississippi is a participating member of the University Press of Mississippi established on May 1, 1970.

The University of Southern Mississippi was established by the State of Mississippi, is owned by the State of Mississippi, and is operated and financed by the State of Mississippi. Its first Board of Trustees was established by the legislative act of March 30, 1910, and that board governed only this one institution. On February 2, 1932, the Legislature established the Board of Trustees of State Institutions of Higher Learning and placed under its jurisdiction the five colleges and one

university owned and operated by the State. On November 3, 1942, the people of the State voted to make the Board of Trustees of State Institutions of Higher Learning a constitutional board for all colleges and universities of the State. The University of Southern Mississippi is now operated under the jurisdiction of that constitutional board.

## 4.2 The College of Science and Technology

The College of Science and Technology provides the student training in all of the classical fields of science, several contemporary multidisciplinary areas, and engineering technology degree programs. The College of Science and Technology is organized into eleven departments and five institutes. The departments include Biological Sciences, Chemistry, Computer Science and Statistics, Construction and Architectural Engineering Technology, Geology, Engineering Technology, Mathematics, Medical Technology, Physics and Astronomy, Polymer Science, and Science Education. The institutes are the Institute of Environmental Science, the Institute of Genetics, the Institute of Microbiology and Related Sciences, the Institute of Surface Coatings, and the Mississippi Polymer Institute. In addition to the degree programs that are synonymous with the above listed department names, degrees are offered in Industrial Engineering Technology, Electronics Engineering Technology, Mechanical Engineering Technology, and Computer Engineering Technology.

Pre-Professional Curricula are offered by the College of Science and Technology in the following health related areas: medicine, dentistry, veterinary medicine, pharmacy, physical therapy, optometry, dental hygiene, and medical records administration. The College also provides a pre-engineering and a pre-architecture curriculum.

The College shares with the College of Education and Psychology joint responsibility for the Department of Science and Education, embracing a sequence of courses titled Fundamentals of Science, and offering a major in science education for teachers.

## 4.3 The Department of Computer Science and Statistics

The Department of Computer Science and Statistics was established in 1965 to meet the great demand for trained personnel in the computing industry. Since 1965, over 1,200 students have obtained degrees in the program. The department currently offers B.S. and M.S. degrees and is comtemplating initiating a Ph.D. program.

Majors in the department currently consist of computer science, business data processing, applied computer science, and statistics. Courses offered by the department include programming languages, compilers, operating systems, computer design, microprocessor interfaces, communication networks, process control systems, analog computing, switching circuits, database design, linear and mathematical programming, simulation, statistics, and other miscellaneous topics.

## 4.4 College Computer Facilities

The primary systems for faculty and student support within the college are a DEC VAX-11/780 and a Harris H-800 computer system. This DEC VAX-11/780 is currently configured with 8 mb of main memory, 512 mb of disk storage, two 8-track tape drives, and a number of miscellaneous peripherals. The system currently supports 80 terminals and can be externally accessed through a number of "dial-up" lines. The Harris H-800 has 3 mb of main memory, 600 mb of disk storage, one 8-track tape drive and supports 20 terminals and 64 "dial-up" lines. Additional computer equipment consists of 60 CRT terminals which are linked to the University Computing Center's Honeywell DPS-8, 8 color graphics terminals, Tektronix 4051, 4052, and 4081 intelligent graphics systems, two flat bed plotters, a Cromemco System-2 microcomputer, 150 Tandy, Apple, and/or IBM microcomputers and a DEC PDP-11/34. In addition, the college is currently in the process of acquiring an additional super-minicomputer and has recently purchased 100 additional microcomputers.

The computer engineering technology program is supported by the following equipment: GENRAD microdevelopment system with capability to generate EPROMS for M6800 or Z80 microprocessors, ten M6800D2 microcomputers, KIM-1 6502 microprocessor, three M6809 microprocessors, three TI 990/189 university board microcomputers, one 16-channel logic analyzer, numerous logic trainers, oscilloscopes and bench meters, and an Intel SDK-2920 analog development system.

## 4.5 Additional Equipment Required

As noted in Section 2.6.1, the technology transfer workstation is being developed on an IBM compatible microcomputer. One of these units is currently available; however, a second unit is required to meet the schedule of Figure 4. The workstation will consist of a suitably configured 16-bit microcomputer using an MS-DOS operating system. The microcomputer will include: 512 kb main memory, 10 mb fixed disk drive, 360 kb removable disk drive, 1200 band modem, string comparator coprocessor, and a graphics printer.

## 5. EXPERIENCE AND PAST PERFORMANCE

The following table describes contracts which involve software development activities carried-out principally by Dr. Huffman. Dr. Leigh has been involved in the NASA-related activities which are also listed below.

TABLE 3
PREVIOUS SOFTWARE DEVELOPMENT CONTRACTS

| CONTRACT TITLE | CONTRACTING AGENCY | CONTRACT PERIOD | CONTRACT AMOUNT | BRIEF DESCRIPTION OF ACTIVITIES |
|---|---|---|---|---|
| Calibration and Software Development for an Intermittent Blow-Down Wind Tunnel | Naval Weapons Support Center | June 5, 1981 - June 30, 1983 | $ 68,178 | Development of real-time control software for an intermittent blow-down wind tunnel used for decoy flare testing. |
| Engineering Technical Support | Naval Avionics Center | December 8, 1981 November 30, 1984 | $ 3,321,707 | A multi-task program with limited software development activities. Software tasks consisted of designing and developing control algorithms using Ada. |
| Development of a Heating System, Life Cycle Cost Computer Program | Indiana Gas and Citizens Gas | August 3, 1981 - March 17, 1982 | $ 53,292 | Development of computer programs for comparison of life-cycle costs for various heating and air conditioning systems. |
| Computer Data Acquistion System | Ford Motor Company | November 1, 1981 - April 16, 1982 | $ 37,047 | Development of real-time control and data analysis software for an automotive radiator test facility. |
| Computer Assisted Operating System | VERCO | January 1, 1983 - December 30, 1983 | $ 50,000 | Development of optimal control algorithms for industrial incinerators. |
| Development of Digital Dynamometer Control Systems | Pontiac Motor Company | March 17, 1982 - February 28, 1983 | $ 75,000 | Development of computer algorithms for the control and data analysis of automotive dynamometers. |
| Technology Transfer Program | NASA | July 1, 1983 - June 30, 1984 | $ 676,000 (1) | Operation of the Aerospace Research Application Center (ARAC). |
| Technology Transfer Program | NASA | July 1, 1984 - June 30, 1985 | $ 1,230,000 (1) | Operation of ARAC and development of software support tools for technology transfer. |
| Technology Transfer Software Development | NASA (2) | July 1, 1985 - June 30, 1986 | $ 86,163 | Development of software support tools for technology transfer. |

(1) NASA funding and client income.
(2) Subcontracted through the Indianapolis Center for Advanced Research.

# 6. REFERENCES AND BIBLIOGRAPHY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